The present invention relates to shaft seals and more particularly to an improved rotary seal of the O-ring type. It is an object of the present invention to provide an O-ring cartridge seal construction which is efficient, reliable and consistent for applications involving moderate speed and pressure differential and which is inherently low in cost.

It is a more specific object of the present invention to provide a cartridge-type seal employing a garter spring and O-ring in which the garter spring is prestressed so that precompression, relative to high per-unit forces are applied at the sealing surfaces but in which means are incorporated for preventing the O-ring from being squeezed out of position in the cartridge prior to installation. In this connection it is an object to provide an improved cartridge-type seal employing an O-ring, garter spring, and retaining ring in which all three elements are effectively locked together for relative rotation as a unit and in which the O-ring and retaining ring are free to move radially through a limited distance in the face of eccentricity or runout while nevertheless being maintained in approximately centered position relative to the cartridge so that the cartridge may be easily installed without risk of pinching or otherwise damaging the O-ring.

Other objects and advantages of the invention will become apparent upon reading the attached detailed description and upon reference to the drawings in which:

FIGURE 1 shows an axial section of a cartridge-type seal constructed in accordance with the present invention.

FIG. 2 is an axial half section of a seal similar to FIG. 1 but employing an expansion-type garter spring.

FIG. 3 is a vector diagram of the components of force exerted by the garter spring.

In accordance with one of the features of the present invention the retaining ring is preferably provided with a lip 55 which extends under the O-ring as shown for retaining the O-ring and supporting it in position in the cartridge prior to cartridge installation. Thus, where the garter spring 50 has substantial prestress and where there is a large radial component of force squeezing the O-ring, the latter will engage and tend to be supported by the lip 55. In order to provide a distribution area of contact under such conditions and also to maintain close spacing between the O-ring and the retaining ring, the retaining ring may be uncritically scalloped to provide a mating surface 56 on the side adjacent the O-ring. By providing the O-ring against inward deformation by the spring, the O-ring does not get in the way when the cartridge is telescoped over the shaft 13. In other words, the O-ring bulges inwardly to only a limited degree and presents a smooth arc on the portion which does project for camming of the latter onto the shaft.

It is, moreover, one of the detailed features of the invention that means are provided for maintaining the entire assembly of O-ring, garter spring, and retaining ring approximately centered with the cartridge and for insuring that the O-ring is maintained centered in the valley 48 between the O-ring and the retaining ring. This is accomplished in the present instance by providing an inward projection 60 on the wall 22 of the cartridge. Such inward projection provides an obstruction 61 which is sufficiently spaced from the O-ring so that the O-ring simply may move in response to eccentricity or runout.
of the shaft but with the radial clearance being limited so that the O-ring assembly is always maintained in a generally centered position for insertion of the shaft and the garter spring. Moreover, the forward projection 60 is located directly opposite the garter spring 50 so that the garter spring is prevented from moving, to the left in FIG. 1, over the top of the O-ring.

Since the retaining ring 40 grips the shaft, and is rotatable with it, the amount of clearance at the outer, i.e., right hand retaining ring is immaterial. Thus, with zero clearance as shown at 57 in the drawing, the seal will function properly if there is some clearance present.

Since, in the embodiment of FIG. 1, the retaining ring, O-ring and garter spring all rotate with the shaft, the garter spring is subject to centrifugal forces, and a measure of protection is provided against an overspeed condition. Thus where the speed of the shaft approaches or exceeds the maximum speed rating, the increase in centrifugal force acting upon the spring tends to reduce the inward squeezing pressure of the spring and thus reduce both the radial and axial components of spring force. This reduces the force per unit area applied at the relatively sliding surface of the O-ring as well as the area in contact, tending to reduce the heat which tends to be generated at such surface under high speed conditions, and which, in an extreme case, might result in burn-up of the surface. While the invention has been described in connection with a cartridge having an O-ring running in contact with a shaft, it will be apparent to one skilled in the art that the invention is not limited to the particular arrangement shown and that the construction may be inverted by use of a modified cartridge and an expansion-type garter spring so that sealing engagement occurs at the outer cylindrical surface 14, i.e., at the surface of the opening in the frame or housing. Thus, referring to FIG. 2, corresponding parts are indicated by corresponding reference numerals with the addition of subscript “a.” In this embodiment the cartridge 16a is open at the periphery for outward presentation of the surfaces of the O-ring 30a and retaining ring 40a. Both of the latter elements are urged outwardly by means of an expansion-type garter spring 50a. The members are proportioned and the surfaces are angled just as in the preceding embodiments so that the type of vector diagram in FIG. 3 is applicable. The lip of the retaining ring 40a extends beyond the outer surface of the O-ring 30a and maintains the entire assembly of the cartridge in a generally centered condition so that no special care need be used in inserting the cartridge into its recess. The retaining ring 40a is preferably of split construction so that its surfaces 41a, under the urging of the garter spring, is capable of gripping the cylindrical surface 14, which it engages.

In the following claims the term “plastic or the like” is intended to cover plastics, such as nylon or other materials having comparable physical characteristics. The term “garter spring” is intended to cover either the usual type capable of exerting force outwardly. The “split” in the ring which is referred to may be a line of severance which extends all the way through the ring at one point, or it may, without departing from the invention, be a series of cuts extending partially through the structure of the ring, weakening it sufficiently so that it is still capable of dimensionally responding to the force exerted by the garter spring to provide the gripping action. Or, if desired, the retaining ring may be made of resilient material having a slightly interfering fit to provide the gripping action without having to rely upon the garter spring. The term “preshressed” refers to the fact that the spring, in both of the two versions has a “normal” diameter, when unstressed, which differs from its “working” diameter when in place in the cartridge, the working diameter being longer, to apply static inward stress in the embodiment of FIG. 1, and smaller to apply outward stress, in the embodiment of FIG. 2, “working diameter being shorter” referred to may be radially inward or radially outward.

In any event it will be apparent that a cartridge-type seal has been provided which is inherently simple and inexpensive and which is capable of operating at moderate speeds and in the face of moderate pressure differentials. If desired, the space within the cartridge may be charged with lubricant in order to insure that the slipping face of the O-ring is adequately lubricated with respect to the surface which it engages.

I claim as my invention:

1. In a cartridge-type seal for insertion in the annular space between a shaft and a frame opening defining first and second concentric cylindrical surfaces, the combination comprising an annular cartridge having a first wall and a second wall, said walls being fixedly mounted with respect to the first cylindrical surface and extending to within the vicinity of the second cylindrical surface to define an annular clearance space with respect to the latter, an O-ring presenting arcuate sealing surfaces in engagement with the first wall of the cartridge and the second cylindrical surface respectively, a retaining ring of plastic or the like arranged adjacent the O-ring for mounting on said second cylindrical surface, said O-ring and retaining ring having approximate cylindrically extended approximately the same radial thickness profiled to define a shallow annular valley between them, a garter spring in said valley, said garter spring being prestressed to exert both the retaining ring and O-ring angled forces having radial components in the same direction as well as axial components in opposite directions, said retaining ring being in gripping engagement with the second cylindrical surface to preclude relative movement between the O-ring and retaining ring.

2. In a cartridge-type seal for insertion in the annular space between a shaft and a frame opening defining first and second concentric cylindrical surfaces, the combination comprising an annular cartridge having a first wall and a second wall, said walls being fixedly mounted with respect to the first cylindrical surface and extending to within the vicinity of the second cylindrical surface to define a cylindrical clearance space with respect to the latter, an O-ring presenting arcuate sealing surfaces in engagement with the first wall of the cartridge and the second cylindrical surface respectively, a split retaining ring of plastic or the like arranged adjacent the O-ring for mounting on said second cylindrical surface, said O-ring and retaining ring having adjacent portions of approximately the same radial thickness profiled to define a shallow annular valley between them, a garter spring in said valley, said garter spring being prestressed to exert radial squeezing forces upon both the retaining ring and the O-ring.

3. In a cartridge-type seal for insertion in the annular space between a shaft and a frame opening defining first and second concentric cylindrical surfaces, the combination comprising an annular cartridge having a first wall and a second wall, said walls being fixedly mounted with respect to the first cylindrical surface and extending to within the vicinity of the second cylindrical surface to define an annular clearance space with respect to the latter, an O-ring presenting arcuate sealing surfaces in engagement with the first wall of the cartridge and in engagement with the second cylindrical surface respectively, a split retaining ring of plastic or the like arranged adjacent the O-ring for mounting on said second cylindrical surface, said O-ring and retaining ring having adjacent portions of approximately the same radial thickness profiled to define a shallow annular valley between them, a prestressed garter spring in said valley for exerting upon the O-ring and split ring, angled forces having both radial and axial components, and means for engaging the garter
spring to prevent axial movement thereof and for thereby maintaining the garter spring seated in said valley.

4. In a cartridge-type seal for insertion in the annular space between a shaft and a frame opening defining first and second concentric cylindrical surfaces, the combination comprising an annular cartridge having a first wall and a second wall, said walls being fixedly mounted with respect to the first cylindrical surface and extending to within the vicinity of the second cylindrical surface to define an annular clearance space with respect to the latter, an O-ring presenting arcuate sealing surfaces in engagement with the first wall of the cartridge and the second cylindrical surface respectively, a retaining ring of plastic or the like arranged adjacent the O-ring for mounting on the second cylindrical surface and in gripping engagement with the latter, a prestressed garter spring bearing against said O-ring in angular relation to provide axial and radial components of force for application to the O-ring sealing surfaces, said garter spring having means for supporting the same in the angled position, said retaining ring having a lip formed thereon extending partially under the O-ring for restraining the O-ring against excessive radial movement as a result of the radial component of force exerted by the garter spring prior to the installation of the seal.

References Cited by the Examiner

UNITED STATES PATENTS
2,747,903 5/1956 Heinrich 277—84 X
3,069,174 12/1962 Skinner 277—143 X
3,193,298 7/1965 Voitik et al. 277—40

FOREIGN PATENTS
1,040,859 10/1958 Germany.

SAMUEL ROTHBERG, Primary Examiner.